



*Unrivalled in
Power Factor
Correction.*



Static VAR Generators (SVG)

What is Power Factor?

Power Factor is a measure of how effectively incoming power is used in your electrical system and is defined as the ratio of Real (working) power to Apparent (total) power.

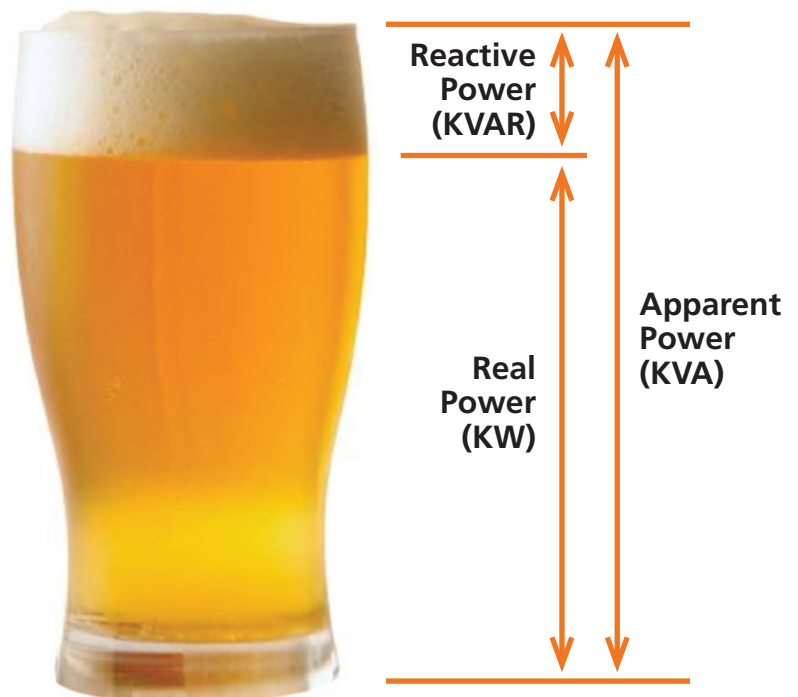
Real Power (KW) is the power that actually powers the equipment and performs useful, productive work. It is also called Actual Power, Active Power or Working Power.

Reactive Power (KVAR) is the power required by some equipment (eg. transformers, motors and relays) to produce a magnetic field to enable real work to be done. It's necessary to operate certain equipment but you don't see any result for its use.

Apparent Power (KVA) is the vector sum of Real Power (KW) and Reactive Power (KVAR) and is the total power supplied through the power mains that is required to produce the relevant amount of real power for the load.

Let's look at a simple analogy in order to better understand these terms. Let's say you've ordered a glass of your favourite beer. The thirst quenching portion of your beer is represented by Real Power (KW). Unfortunately, along with your ale comes a little bit of foam that doesn't quench your thirst, represented by Reactive Power (KVAR). The total contents of your glass (KVA) is this summation of KW (the beer) and KVAR (the foam).

The power factor is the ratio between Real Power and Apparent Power. It's expressed as a value between -1 and 1 and can be either inductive (lagging) or capacitive (leading). If the power factor is 1, then all of the power supplied is being used for productive work and this is called 'unity'.



$$\text{Power Factor} = \frac{\text{Real Power (KW)}}{\text{Apparent Power (KVA)}} = \frac{\text{Beer}}{\text{Beer + Foam}}$$

Therefore, for a given power supply (KVA):

- The more foam you have (the higher the percentage of KVAR), the lower your ratio of KW (beer) to KVA (beer plus foam). Thus, the poorer your power factor.
- The less foam you have (the lower the percentage of KVAR), the higher your ratio of KW (beer) to KVA (beer plus foam) and the better your power factor. As your foam (or KVAR) approaches zero, your power factor approaches 1.0 (unity).

The Need for Power Factor Correction

A power factor of -0.7 for example, indicates that only 70% of power supplied to your business is being used effectively and 30% is being wasted. The wasted power is the Reactive power (the foam in the previous example). Most loads are inductive in nature, which means the power factor will typically be less than unity. The further the power factor is from unity, the greater the apparent power drawn and therefore, the greater the current draw for the system.

The increased current may require an increase in the size of your transformers and installation power wiring. Increased current also results in increased heat which affects the longevity and lifespan of an electrical system. This can add a great deal of cost to the installation and may also limit the expansion of a plant.

Why is Power Factor important?

It's important because you may be paying for reactive power (foam) that you cannot use to power equipment. If you can reduce the foam, you can get more 'beer for your buck'. Improving the power factor results in less current being drawn, therefore less electricity costs, less heat and greater longevity of the electrical system.

Many power suppliers charge for the base load (kW) and a maximum demand tariff. If this maximum demand tariff is measured in kVA, then improving the power factor reduces the kVA of the installation, thus reduces the maximum demand tariff and thereby reducing your power costs.

It is actually a network regulation that customers maintain a specific minimum power factor (values depend on your region). Utility companies may charge customers a penalty on top of consumption charges when customer power factor is less than a determined value.

What is Power Factor Correction?

Poor Power Factor can be improved by installing Power Factor Correction (PFC) equipment. Traditional solutions incorporate banks of capacitors that work as silent reactive power 'generators', often housed in a metal cabinet similar to the one that houses your electrical switchboard.

Fuseco offers the latest generation of advanced performance PFC solutions that do not need a capacitor bank and offer many advantages due to their compact and modular configuration.

How Can Power Factor Correction Help You?

An electrical load with a poor power factor draws more current than a load with an improved power factor for the same amount of useful power transferred and can put unnecessary strain on the electricity distribution network. By improving your power factor, you can reduce your electricity bills through lower monthly demand and capacity charges. Typically payback periods for power factor correction are between 1-3 years. Given the life expectancy of power factor correction equipment and the potential savings, it can be a very worthwhile investment.

Poor power factor may cause power losses and voltage drops, which can contribute to overheating and failure of motors and other equipment. If your electrical system is near capacity, installation of power factor correction equipment may help avoid costly infrastructure upgrades by lowering the existing electrical demand on your system and improving efficiency stability.

The Evolution of PFC Systems

Power Factor Correction systems have come a long way in a short space of time. Most of the evolution has focused on the switching performance of the system however in recent times, advances in technology have removed the need for switched capacitor banks, resulting significantly faster performance and smaller cabinet footprint.

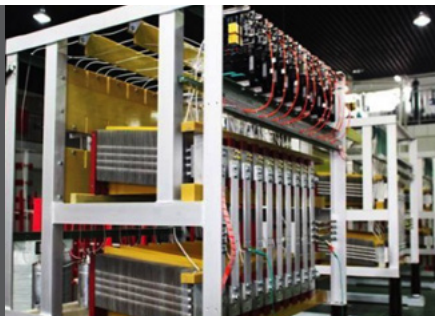
Fixed compensation



Automatic switching



Thyristor half-controlled switching



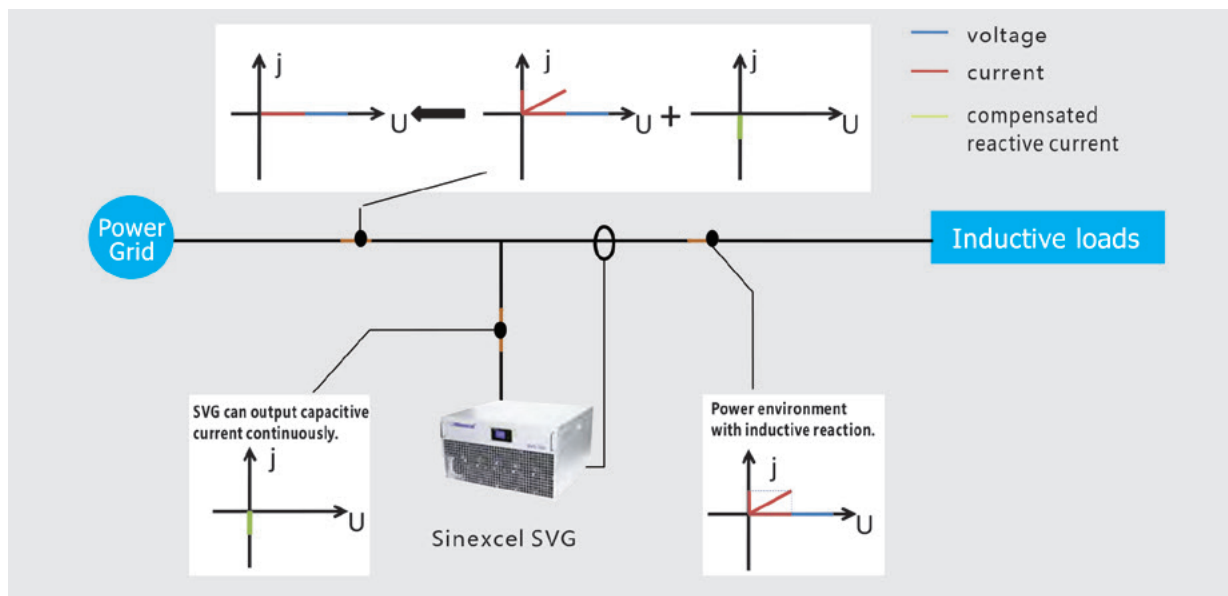
IGTB intelligence controlled switching



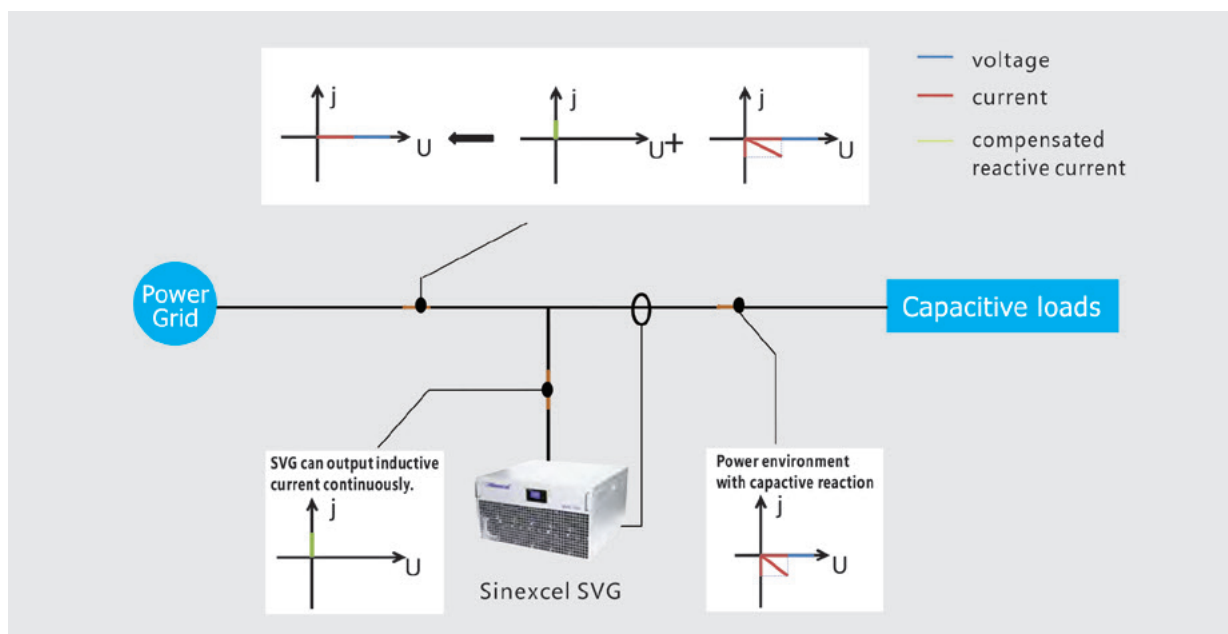
Operating Principle of the SVG

The Sinexcel SVG represents the latest generation technology in the power factor correction field. It operates by detecting the load current on a real-time basis through an external CT's and determining the reactive content of the load current. The data is analysed and the SVG's controller drives the internal IGBT's by using pulse width modulation signals to make the inverter produce the exact reverse reactive current of the corresponding load reactive content. This is injected to the grid to compensate the reactive content of the load current. By adjusting the output voltage amplitude and phase angle or by directly controlling the AC side current, the SVG can absorb or generate var according to the load reactive power or the grid voltage level.

Sinexcel SVG compensate inductive loads



Sinexcel SVG compensate capacitive loads



Advanced Performance

Excellent power factor correction performance

- Can maintain a PF of 0.99 lagging or unity if required

Compensates both inductive and capacitive loads

- Corrects lagging and leading power factor (-1 to +1)

Eliminating the weakest link

- The new method of PFC from Sinexcel takes away the most vulnerable and weakest link in a traditional PFC system – the switched capacitors. Various environmental conditions (eg. excessive temperature, over-voltage, harmonic distortion) may cause capacitors to rupture and ignite.
- The average life span of a switched capacitor is heavily dependent on the ambient temperature in which it is operated – requiring careful selection with respect to permissible operating temperature range. These temperature limits work well in colder climates but may not necessarily work well in Australia. The new generation technology in the SVG eliminates the operational limitations, safety concerns, space demands and life span issues of capacitor banks.

Operates in all 3 phases

- A traditional switched capacitor type PFC system measures one phase and provides stepped kVAR compensation only to that phase, irrespective of what the other two phases need.
- The Sinexcel SVG measures and provides dynamic kVAR compensation throughout all three phases.

Greater longevity

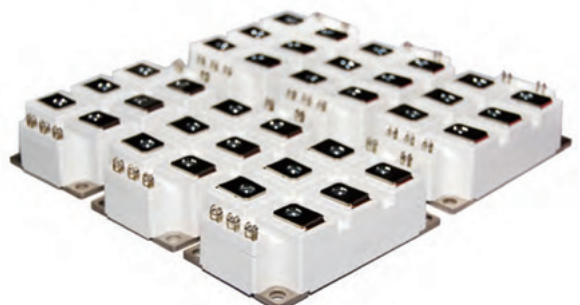
- With traditional capacitor systems, when smaller steps are needed for fine adjustment, the space required for either 6.25kVAR or 50kVAR steps is the same. The other disadvantage for having a small step for fine adjustment is that it gets over used (frequently switched). The PFC controller uses an algorithm that evenly distributes the work load amongst the available steps except when one or two of those steps are of a smaller capacity. This brings into play the actual useable lifetime of the components used, for example the life of the contactor!

Not affected by resonance

- The Sinexcel system is not susceptible to existing harmonics and therefore does not need a blocking reactor and is unaffected by resonance whereas for the traditional PFC system this is very much a problem.

Corrects load imbalance

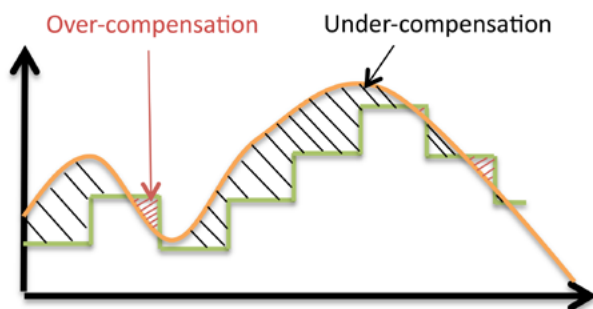
Can operate at low voltages



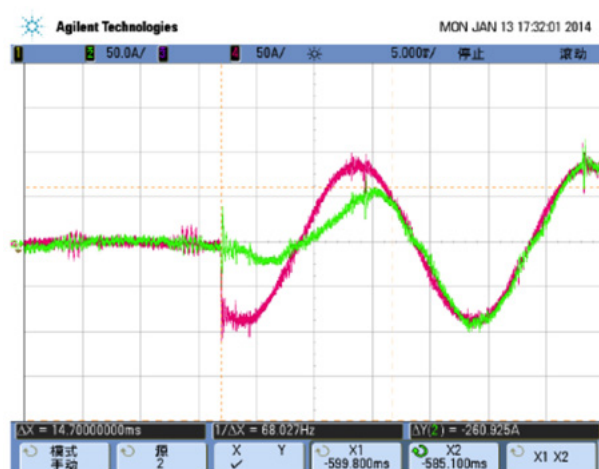
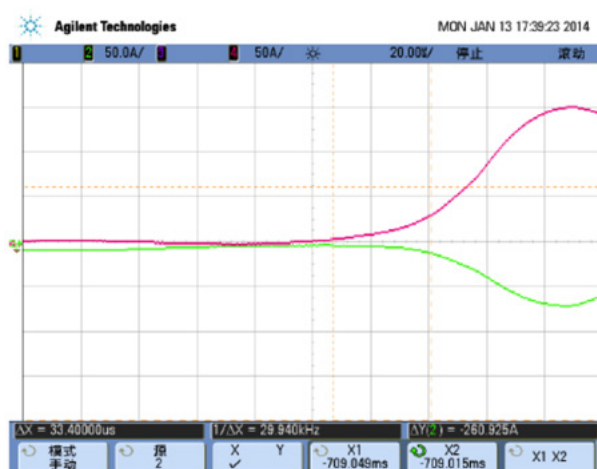
Advanced Performance

Dynamic step-less compensation

- Profiles the load and operates with a response speed of $<15\text{ms}$
- Dynamic reaction time is less than $50\mu\text{s}$
- No possibility of over-compensation or under-compensation
- Only injects the kVAr that is needed in that moment



Traditional capacitor type PFC systems take 20ms-40s to respond to a change in load. Their delay combined with the stepped response performance means that they are perpetually over or under compensating.



SVG Reaction Time $<50\mu\text{s}$, response time $<15\text{ms}$

The Sinexcel recalculates the required load accurately and quickly. The IGBT technology switches with high speed, quickly matching the load requirement.

The genius of simplicity

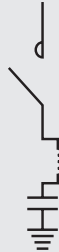
- Virtually maintenance free
- Can be used with existing PFC systems
- High reliability and safety

Advanced Performance

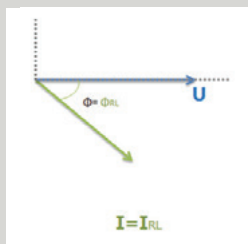
Comparison between a commonly used capacitor type system and the latest generation power factor correction technology from Sinexcel (SVG)

Capacitor type PFC system

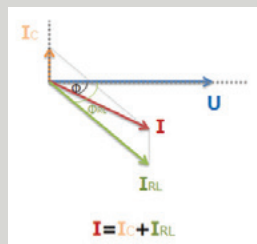
The system detects the load current on a real-time basis through an external CT and determines the reactive content of the load current. The data is analysed and the system's controller switches in the required amount of reactive current in steps, depending on the amount of reactive current available to it in that moment from the capacitor bank.



Before compensation



After compensation



Traditional PFC systems use capacitors in groups. Their output current is in fixed steps (50kVAR, 25kVAR, 12.5kVAR, 6.25kVAR) which usually leads to over or under-compensation.

Capacitor bank style PFC systems take at least 20ms - 40s to perform compensation depending upon whether the switching is done via a solid state switch or a contactor.

Traditional PFC systems are affected by resonance, which is detrimental to the capacitors. To lower the risk, de-tuning reactors are introduced into the circuit to lower the resonant frequency below that of the lowest harmonic in the circuit.

Capacitor bank style PFC systems can only compensate for inductive loads.

Capacitor output is subject to the voltage of the grid, so if the grid voltage is low the output of the capacitors will be low, resulting in a decline in available compensating capacity, under-compensation and possible fault conditions.

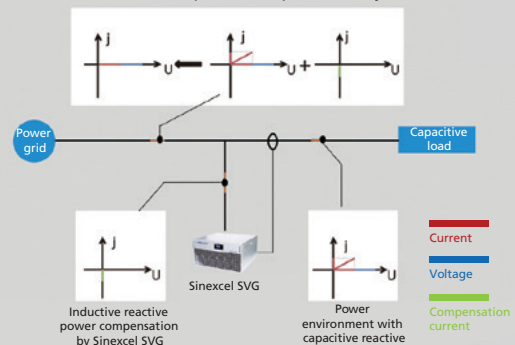
To better suit the changing dynamics of the load a traditional capacitor type PFC system needs to be oversized and to have a greater number of smaller steps to better suit the application. This increases the cost significantly.

SVG

The SVG detects the load current on a real-time basis through an external CT's and determines the reactive content of the load current. The data is analysed and the SVG's controller drives the internal IGBT's by using PWM signals to make the inverter produce the exact reverse reactive current of the corresponding load reactive current.



Capacitive reactive power compensation by Sinexcel SVG (vector graph)
PF=0.99 after reactive power compensation by Sinexcel SVG



The SVG performs as a controlled current source, thus obtaining a power factor of 0.99 lagging whilst avoiding over-compensation and under-compensation.

The complete response time of the SVG is less than 15ms and the dynamic response time is less than 50μs. The SVG can track the dynamics of the load and compensate accordingly in almost real-time.

The capacitance of the SVG does not require the installation of a de-tuning reactor. Performing as a current source and an active compensation device the SVG has been designed to not be affected by resonance.

The SVG can correct both a lagging and a leading power factor, as well as work with a traditional capacitor type PFC system to eliminate over and under compensation.

Designed with an active compensation circuit. Therefore the voltage of the grid has little influence on the compensation capacity. The output of reactive current matches the working conditions even when the voltage of the power grid is low.

The compensation capacity of the SVG is the same as the installed capacity. Therefore for a given compensation effect the capacity of the SVG may be 20% - 30% less than that of a standard capacitor type PFC System.

Key Features

Easy to Use Graphical User Interface

The Sinexcel SVG series integrates a HMI including a graphical user interface. It offers direct control, configuration, monitoring and harmonics analysis of the SVG without the need of a PC. Communication options, detailed alarm events and fault reporting with real time stamp are also included.

Backlit Display

Incorporating a high level of readability and ease of menu navigation, the backlit LCD display offers:

- Access and configuration of operating parameters
- Measurement data in numerical, graphical and spectrum formats
- Operation status inclusive of detailed alarms and fault messages
- Password protected for critical settings

Measurements

Provides a comprehensive set of measurement data for analysis, such as:

- Power factor (grid/load)
- Current (grid/load, PF, THDi, waveform, spectrum)
- Voltage, grid voltage, frequency, Tdhu, grid voltage waveform, spectrum
- IO & temperature, IO status, temperature
- Power analysis (Apparent, Active, Reactive, $\cos\phi$)

Alarms and Fault Reporting

Detailed alarms and fault messages with real time stamping are provided for quick troubleshooting.

Modes of protection include:

- | | |
|---|----------------------------------|
| ■ Over-temperature | ■ Malfunction of ventilation fan |
| ■ Inverter bridge in event of abnormal operations | ■ Communication faults |
| ■ Over and under voltage | ■ CT Phase Rotation |

Ease of Installation & Commissioning

- Designed to be a 'Plug & Play' experience for the user
- Installation & Commissioning process is the industry benchmark for simplicity and ease of use.
- Fuseco provide comprehensive customer support from our Power Quality Consultants

Available in Various Configurations

- Available in IP20, IP31 and IP54 versions to suit a wide variety of industry applications

1 Year Warranty (conditions apply)

Modular, Compact Size and Light Weight

Due to the operational temperature and safety requirements applicable to capacitor banks, traditional PFC systems are constructed as a separate, stand-alone assembly or in self-contained spaces within the overall construction of the main switch board. This results in the common situation where PFC systems occupy a large space, often taking up valuable floor space in switch rooms.

Sinexcel have applied new generation thinking and innovative design principles to create a new generation of PFC solutions that has redefined what is possible from a cost vs performance vs space perspective.

Sinexcel SVG are a modular design that are available in wall-mount, rack-mount and rack/cabinet configurations. This flexibility gives engineers multiple options to cater for all situations and ultimately save valuable space and floor real-estate.

Compensating kVAr Capability vs Space

- ✓ Up to 100kVAr capability from a wall-mount solution
- ✓ Up to 100kVAr capability from a single rack-mount module
- ✓ Up to 400kVAr capability from a single standard cabinet solution
- ✓ Up to 500kVAr capability from a single 'drawer-type' cabinet solution

50kVAr Solutions



- ▲ 50kVAr Rack-Mounted SVG
500W x 510D x 190H (mm)
Weight: 35kg



- ▲ 50kVAr Wall-Mounted SVG
500W x 192D x 560H (mm)
Weight: 35kg

100kVAr Solutions



- ▲ 100kVAr Rack-Mounted SVG
500W x 520D x 270H (mm)
Weight: 48kg



- ▲ 100kVAr Wall-Mounted SVG
505W x 271D x 545H (mm)
Weight: 48kg

Cabinet Solutions



- ▲ Standard Cabinet
- up to 400kVAr
capacity possible



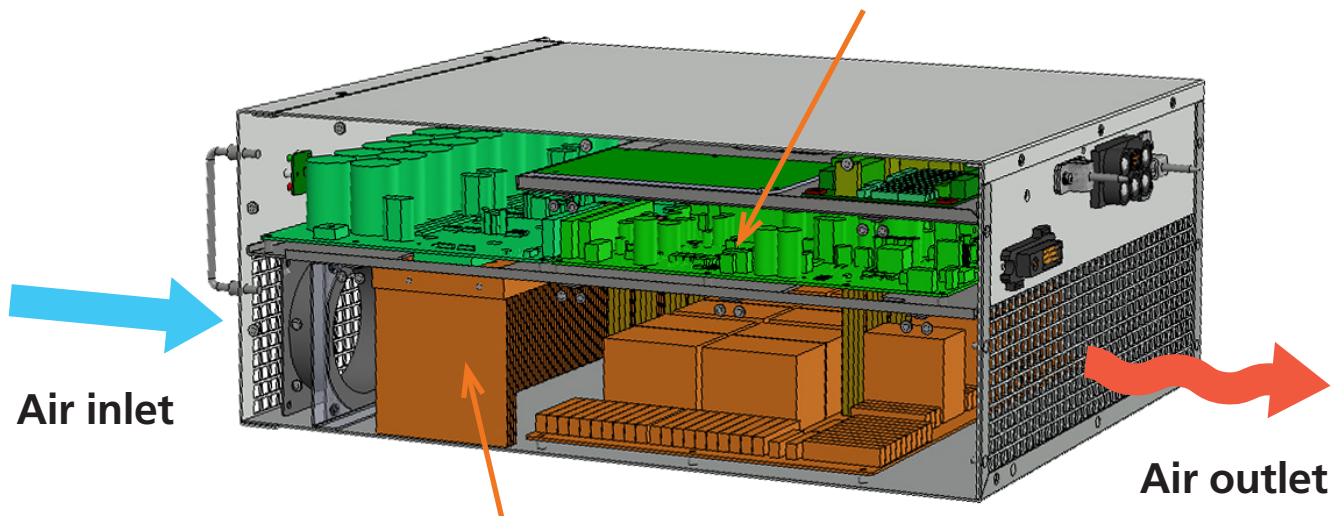
- ▲ Special Drawer Cabinet
- up to 500kVAr
capacity possible

Intelligent Design

Designed for Efficiency & Minimal Maintenance

Minimising Dust Ingress

Electronic components separated from heat producing components and housed in their own sealed compartment, resulting in greater protection from the effects of heat and dust ingress.



Optimum Heat Dissipation

Heat sinks, IGBT's, inductors and other heat producing components housed in a separate compartment optimised for efficient ventilation and cooling.

Protection Features

- Internal short circuit protection
- Temperature monitoring
- Over-voltage protection
- Under-voltage protection
- Abnormal frequency protection
- Output overload protection
- CT installation detection
- Inverter bridge abnormal operation protection
- Inverter over-current protection
- Over compensation capacity
- Component capacity redundancy
- Fan fault protection
- Fuse protection
- Busbar over-voltage protection

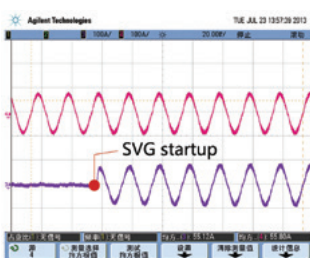
Actual example

Screen shot from a SVG installation

Sinexcel 70-400-4L		15-11-2014 M102D100		10:31:35
		Power Factor	COSPHI	Neutral Current
Load	A	0.81	0.81	2.96
	B	0.69	0.68	
	C	0.73	0.73	
Grid	A	0.99	1.00	18.59
	B	0.99	1.00	
	C	0.99	1.00	

Graphical representation of SVG performance

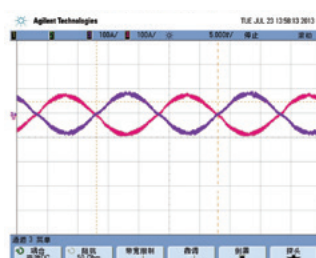
System reactive current



Quick Response

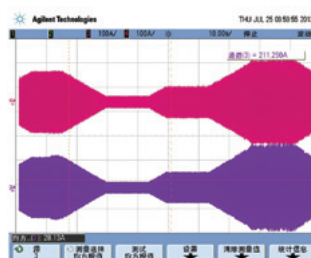
The system reactive power compensation is created immediately upon the start-up of the Sinexcel SVG.

Sinexcel SVG compensated reactive currents



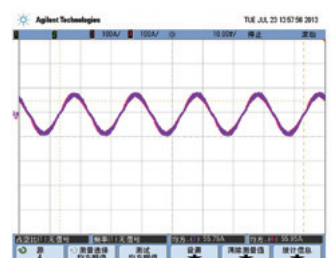
Ideal Compensation

Sinexcel SVG creates a compensation current that has the same capacity as the system reactive current, but in opposite phase.



Real-time Tracking

Sinexcel SVG can create dynamic and real-time compensation currents based on the changes of the system reactive current.



Reverse Overlapping

After the compensation current is phase-reversed, the system reactive current overlaps with the reactive current released by the Sinexcel SVG.

Site Audit

A Power Quality Site Audit is a service offered by Fuseco to our customers. A Power Quality Consultant visits your site and conducts a power quality audit of your electrical system.

This involves setting up sophisticated measuring equipment on site that monitors and records all of the electrical activity that is occurring within the system over a period of time. The equipment is compact, easily transportable to most locations and can be set up indoors or outdoors.

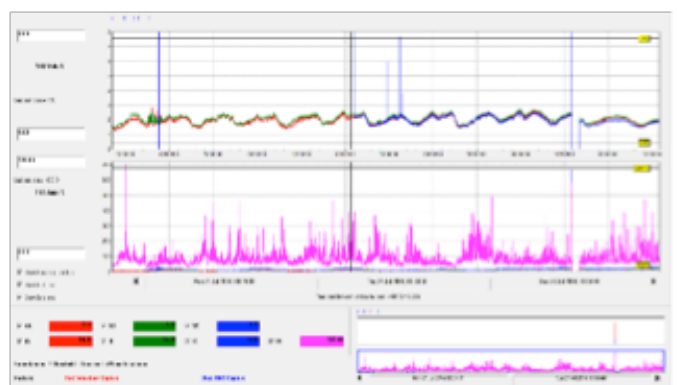
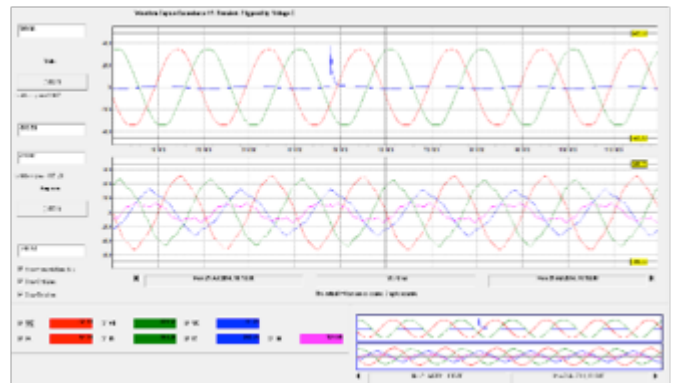
An analysis of the recorded data usually helps to reveal any harmful harmonics, voltage supply and power factor issues. Our power consultant will consider the data and present you with a power quality report, outlining the observed issues and suggesting solutions if required.

Audits are useful in determining electricity usage inefficiencies and identifying damaging harmonics which occur in electrical systems.

Even correctly functioning power systems require routine auditing to ensure early identification of any potential issues and proactive servicing requirements to keep power equipment operating to its full potential and the electrical environment complying to the Australian Standard AS/NZS 61000.3.6 and compatible with the IEEE519 recommendations.

A correctly functioning system could save you upwards of 30% off your power bills. In some industries and installations, that could translate to significant increases to your bottom line. By running an efficient system you also use less energy and therefore help the environment.

To discuss our site analysis service in more detail, please contact a power quality consultant at Fuseco.



Technical specifications

Voltage of Rated AC Input Line	400V
Input Phase Voltage Range	-40% to 20%
Rated Frequency (Hz)	50Hz (45-63Hz Range)
Network Structure	3P3W, 3P4W
Maximum Multiple Units	8
Modes of Operation	Power Factor Correction, Load Balancing
Operation Range	-1 to 1 capacitive to inductive, continuously adjustable
Efficiency	>97%
Power Loss	<3%
Topology Design	3 Level
Full Response Time	<15ms
CT Rating Settings	150/5-10,000/5
Resonance Protection	Yes
Noise Level	<65dB
Communication Interface	RS485, CAN and network port
Communications Protocol	Modbus, PMBus
Self Protection	Yes
Alarm & Reporting	Detailed alarms and fault messages with real time stamping
Monitoring	Via centralised monitoring LCD Screen / PQ Software (included)
Altitude Operating Limit	1500m, 1% power reduction for each additional 100m, between 1500m & 4000m
Operating Temperature Range (Ambient)	-10°C to 40°C
SVG Storage Transportation Temperature Range	-20°C to 70°C
Relative Humidity	Max <95% without condensation
Ingress Protection	IP20 (other IP classes are available with cabinet configuration)

Model	Sinexcel 50kVAr	Sinexcel 100kVAr
Rated Compensation Capacity	50kVAr	100kVAr
Wall-Mount Option	Yes	Yes
Wall-Mount Dimensions (mm)	500W x 192D x 560H	505W x 271D x 545H
Rack-Mount Option	Yes LED versions are used in stand alone cabinets that have a touch screen on the front door LCD versions are used where there is no touch screen required (eg. when 2-4 units are connected in parallel)	
Rack-Mount Dimensions (mm)	500W x 510D x 190H	500W x 520D x 270H
Net Weight (kg)	35	48
Smart Air Cooling	220L/Sec	405L/Sec
Cable Entry	Wall mount is top connect, Rack-mount is rear connect & Cabinet is top and bottom connect	
Cabinet Options	3 standard cabinet sizes available: (1) 600W x 1000D x 2200H, (2) 800W x 1000D x 2200H & (3) 800W x 800D x 2200H	
Cabinet Capacity:	Up to 400kVAr capacity possible from standard cabinet. 500kVAr capacity possible from special 'drawer' type cabinet	



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